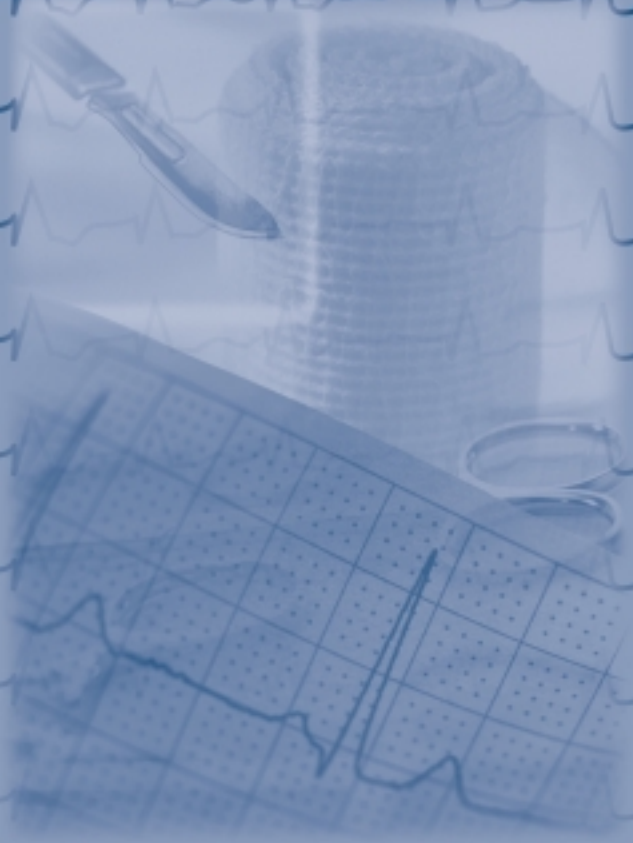
Cardiac Surgery in New Jersey

Technical Report



NEW JERSEY DEPARTMENT of HEALTH and SENIOR SERVICES

Donald T. DiFrancesco
Acting Governor

George T. DiFerdinando, Jr., M.D.
Acting Commissioner
Department of Health and Senior Services

New Jersey's Cardiovascular Health Advisory Panel (CHAP)

Charles Dennis, MD, **Chairman**
Chief of Cardiology
Deborah Heart and Lung Center

Devendra K. Amin, MD, FACC, FACP, FCCP
Medical Director
Warren Hospital Cardiac Catheterization Lab
Phillipsburg

Fred Aueron, MD
Director, Invasive Cardiac Services
St. Barnabas Health Care System

Anthony J. DelRossi, MD
Chief, Department of Surgery
Cooper Hospital/University Medical Center
Camden

Ronnie Gilligan
HR Strategic Partner
AT&T

Mary Jo Goodman, RN, MBA
Director, Cardiac and Critical Care Services
Somerset Medical Center

David V. Habif, Jr., MD
Member, HCAB
Tenafly

Michael B. Kesselbrenner, MD, FACC, FACP
Garden State Cardiology
Paramus

Austin H. Kutscher, Jr., MD, FACC
Cardiovascular Associates
Flemington

Clifton R. Lacy, MD
Senior Vice President Medical Affairs
Robert Wood Johnson University Hospital

Glenn Laub, MD
Chairman, Dept. of Cardiothoracic Surgery
St. Francis Medical Center

Donald Liss, MD
Patient Management Medical Director
Aetna US Healthcare

Grant Parr, MD
Mid-Atlantic Surgical Associates
Morristown

Milton Prystowsky, MD
Member, Public Health Council
Nutley

Nancy Redeker, PhD, RN
Rutgers, The State University of New Jersey
College of Nursing

Vincent Spagnuolo, Jr., MD, FACC
Larchmont Medical Center
Mt. Laurel

William Tansey, III, MD
Summit Medical Group, PA
Short Hills

Barbara Taptich
Johnson and Johnson
Mercerville

Edward Tetelman, Esq.
Director, Office of Legal & Regulatory Affairs
New Jersey Department of Human Services

Rita Watson, MD
Monmouth Cardiology Associates
Long Branch

NEW JERSEY DEPARTMENT of HEALTH and SENIOR SERVICES

Contents

Tables and Figures

Executive Summary

This is a report on the quality of care provided by hospitals and surgeons performing bypass surgery in New Jersey. It is the fourth in a series that seeks to provide consumers with useful information on the quality of surgical care. It provides patient mortality or death rates for the 14 hospitals performing this common cardiac surgical procedure in 1999 and 52 physicians performing this common surgical procedure during 1998 and 1999. The rates are adjusted statistically by factors based on the health condition of patients before surgery.

• Heart Disease and Bypass Surgery are widespread in the United States.

According to the American Heart Association, almost every 30 seconds someone somewhere in this country suffers a heart attack. About once every minute someone dies from a heart attack. Heart disease is the leading killer of Americans; its most common form is coronary artery disease.

Coronary artery disease occurs when walls of the vessels that carry blood to the heart muscle become clogged—partially blocked—with fat and cholesterol deposits. This can lead to chest pains—called angina—which are warning signs of heart attacks. A heart attack occurs when the vessels carrying blood to the heart muscle are totally blocked.

One of the most widespread treatments for coronary artery disease is bypass surgery. Because useful information on this surgical operation may be indispensable for many people, this report aims at providing the necessary data, information and analysis.

• This analysis recognizes that mortality depends on both the surgical care provided by hospitals and surgeons, and the health history of patients.

Even though the risk of patients dying during or after bypass surgery may depend on the surgical care they receive, risk is also dependent on their health condition before the bypass surgery. For instance, an 85-year-old man who has diabetes and has suffered previous heart surgery is at a higher risk of dying when undergoing this surgery than a 50-year-old man with no history of chronic disease or cardiac surgery. To be fair, our analysis on how well hospitals and surgeons performing bypass surgery are doing:

- adjusts the observed death rates estimated for each surgeon and hospital, by factors based on each patient's before-surgery health condition; and,
- uses a clinical panel to exclude extremely sick patients at the highest risk of death during or after surgery.

This adjustment gives hospitals and surgeons who operate on less healthy patients "extra credit." That way such hospitals and surgeons are not at a disadvantage when the results of our analysis are presented. Table ES-1 presents before-surgery health factors, sometimes called risk factors, that were identified as important for predicting bypass surgery deaths in 1999. These factors include patients' age, their gender, and whether or not they have a history of surgery or kidney failure.

• This analysis reports on hospitals using 1999 data, and reports on surgeons using 1998–1999 data.

The analysis for this report used data on all adult patients in New Jersey who underwent bypass surgery with no other major surgery during the same admission. For hospitals, we used 1999 data, the most recent complete data available for analysis. To produce risk-adjusted patient mortality estimates for bypass surgeons, At least two years of data are necessary. Therefore, to produce estimates for surgeons in this report, we combined 1998 and 1999 data, the most recent complete two-year data sets available.

The Department of Health and Senior Services sets the criteria for collecting data and checks the data using traditional quality checking procedures. Independent external teams of medical chart reviewers also audit and verify the accuracy of the data against the actual clinical records at each hospital. If discrepancies are found between the data submitted and the clinical records, hospitals must either provide corroborating documentation or revise their data. Using other data sets, the Department also verifies the data submitted to confirm that all bypass surgical operations and all deaths from bypass surgery were reported.

TABLE ES-1:

LIST OF BEFORE-SURGERY RISK FACTORS IDENTIFIED FOR ISOLATED BYPASS SURGERY DEATHS (1999)

Demographic Factors
- Age 70–74
- Age 75–79
- Age 80–84
- Age 85 and Over
- Female

Health Factors
- Previous Heart Attack
- Congestive Heart Failure in the 2 weeks before surgery
- Kidney Failure with Dialysis
- Kidney Failure without Dialysis
- History of a Stroke
- Lung Disease

Factors related to functioning of the heart
- Ejection Fraction less than 30%
- Cardiogenic Shock present at the time of bypass surgery

Other Factors
- Previous Open Heart Surgery

- **The risk-adjusted mortality for bypass surgery patients in most hospitals in 1999 was not different from the state average.**

The state average mortality for bypass surgery patients in 1999 was 2.89 percent out of 8,108 bypass operations performed. Using the identified before-surgery health factors, we adjusted the estimates of patient mortality for each hospital in 1999. These adjusted estimates are meaningful when compared to the average state mortality. That comparison is presented in Table ES-2.

In 1999, none of the hospitals had risk-adjusted patient mortality statistically higher than the state average. One hospital (Jersey Shore Medical Center) had a risk-adjusted patient mortality estimate statistically lower than the state average. For all other hospitals, the mortality estimates were not statistically different from the state average.

- **The risk-adjusted patient mortality estimates for most surgeons in 1998–1999 were not different from the state average.**

In Table ES-3, we present similar estimates of risk-adjusted patient mortality for surgeons who performed more than 100 operations in two years (1998 and 1999) and compare them to the state average. The state average mortality for bypass surgery patients in the two years (1998–99) was 2.74 percent out of 16,485 bypass operations performed. The table shows that three surgeons had risk-adjusted patient mortality estimates significantly higher than the state average. It also shows three other surgeons whose patient mortality estimates were significantly lower than the state average. For the majority of surgeons, however, the mortality estimates were not statistically different from the state average.

TABLE ES-2:

RISK-ADJUSTED PATIENT MORTALITY FOR HOSPITALS COMPARED TO STATE AVERAGE (1999)

● Lower than 1999 New Jersey average

◓ Same as 1999 New Jersey average

○ Higher than 1999 New Jersey average

Hospitals	Number of Bypass Operations	Risk-adjusted Patient Mortality
Cooper Hosp/Univ MC	274	◓
Deborah Heart and Lung Center	764	◓
General Hosp Center at Passaic	375	◓
Hackensack Univ MC	794	◓
Jersey Shore MC	485	●
Morristown Memorial Hospital	1,136	◓
Newark Beth Israel MC	448	◓
Our Lady of Lourdes MC	834	◓
RWJ Univ Hospital	1,043	◓
St Francis MC	213	◓
St Joseph's Hosp and MC	462	◓
St Michael's MC	508	◓
UMDNJ Univ Hospital	165	◓
Valley Hospital	607	◓

SOURCE: New Jersey Department of Health and Senior Services

TABLE ES-3:

RISK-ADJUSTED PATIENT MORTALITY FOR SURGEONS COMPARED TO STATE AVERAGE (1998–99)

● Lower than 1998–99 New Jersey average
◒ Same as 1998–99 New Jersey average
○ Higher than 1998–99 New Jersey average

Surgeons	Bypass Operations	Risk-adjusted Patient Mortality	Surgeons	Bypass Operations	Risk-adjusted Patient Mortality
Cooper Hosp/University Medical Center					
Cilley, Jonathan	142	◒	Seven Other Surgeons	286	
Mara, Steven	119	◒			
Deborah Heart and Lung Center					
Anderson, William	310	◒	Ng, Arthur	290	◒
Grosso, Michael	282	◒	One Other Surgeon	15	
McGrath, Lynn	649	◒			
General Hospital Center at Passaic					
Goldenberg, Bruce	169	◒	Saxena, Amarkanth	254	◒
Kaushik, Raj	258	◒	Four Other Surgeons	151	
Hackensack University Medical Center					
Alexander, John	120	◒	Hutchinson, John	240	○
Brenner, William	152	◒	Praeger, Peter	376	◒
Elmann, Elie	277	◒	Somberg, Eric	417	◒
Jersey Shore Medical Center					
Dejene, Brook	106	◒	Rajaii-Khorasani Ahmad	232	◒
Neibart, Richard	215	◒	Five Other Surgeons	234	
Oselava, Mark	214	◒			
Morristown Memorial Hospital					
Brown, III, John	489	◒	Parr, Grant	286	◒
Casale, Alfred	427	◒	Rodriguez, Alejandro	363	◒
Johnson, David	307	●	Two Other Surgeons	133	
Magovern, Christopher	308	◒			
Newark Beth Israel Medical Center					
Gielchinsky, Isaac	122	◒	Saunders, Craig	194	◒
Karanam, Ravindra	269	◒	Eight Other Surgeons	277	
Our Lady of Lourdes Medical Center					
Di Paola, Douglas	233	◒	Nayer, Amrit	187	◒
Eisen, Morris	161	◒	Ray, Subhash	105	◒

TABLE ES-3 (continued)

Surgeons	Bypass Operations	Risk-adjusted Patient Mortality	Surgeons	Bypass Operations	Risk-adjusted Patient Mortality
Heim, John	159	○	Santaspirit, John	213	◒
Kuchler, Joseph	258	◒	Eight Other Surgeons	216	
Luciano, Pasquale	244	◒			
Robert Wood Johnson University Hospital					
Krause, Tyrone	987	◒	Spotnitz, Alan	204	◒
Scholz, Peter	232	◒	Vasseur, Bernard	165	◒
Scott, Gregory	469	◒	One Other Surgeon	40	
St Francis Medical Center					
Laub, Glen	421	●	One Other Surgeon	30	
St Josephs Hospital and Medical Center					
Defilippi, Vincent	300	◒	Mekhjian, Haroutune	460	◒
Levy, Dale	120	◒	Two Other Surgeons	42	
St Michaels Medical Center					
Asher, Alain	339	◒	Esrig, Barry	168	●
Codoyannis, Aristides	282	◒	Eleven Other Surgeons	200	
UMDNJ University Hospital					
McCormick, J.	108	○	Four Other Surgeons	166	
Valley Hospital					
Bronstein, E.	480	◒	Rubinstein, M.	245	◒
Mindich, Bruce	434	◒	Two Other Surgeons	135	

TABLE ES-4:

ANNUAL RISK-ADJUSTED MORTALITY COMPARED TO AVERAGE FOR THE PERIOD (1994–99)

● Lower than 1994–99 New Jersey average

◒ Same as 1994–99 New Jersey average

○ Higher than 1994–99 New Jersey averag

Calendar Year	Number of Bypass Operations	Risk-adjusted Mortality	Yearly change in Risk-adjusted Mortality (%)	Change from 1994 Risk-adjusted Mortality (%)
1994	6,957	○	—	—
1995	7,553	○	0.25	6.2
1996	8,262	○	–0.55	–7.5
1997	8,286	◒	–0.69	–24.6
1998	8,377	●	–0.55	–38.3
1999	8,108	●	0.08	–36.3

- **The risk-adjusted patient Bypass Surgery mortality estimates statewide from 1994 through 1999 show a downward trend.**

The experience reported by states that publicly disclose bypass surgery outcomes is that such disclosures have led to quality improvement initiatives resulting in significant reductions in bypass surgery mortality. We compared the statewide risk-adjusted patient mortality for each year in 1994–99 to the yearly average for the period, and present our results in Table ES-4.

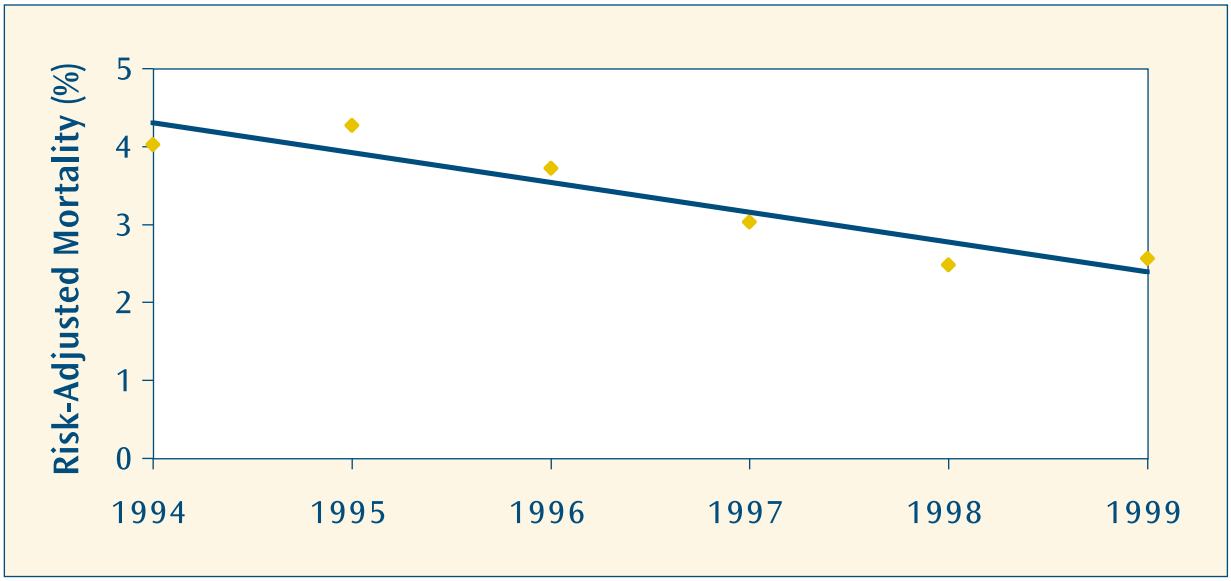
It shows that over most of the six years, the risk-adjusted patient mortality dropped by more than 0.50 percentage points per year. One exception is 1999, when risk-adjusted mortality increased very slightly, by 0.08 percentage points. This increase is not statistically significant. When compared to 1994, in fact, patient mortality in 1999 dropped by more than 36 percent. The annual risk-adjusted mortality numbers, which are plotted in Figure ES-1, show an overall downward trend in mortality in New Jersey.

- **The information presented here should help promote quality improvements in hospitals.**

Hospitals and surgeons can use the information presented in this report as they try to understand the health risks for potential bypass surgery patients in New Jersey. Such information encourages them to examine their surgical procedures and make changes to improve the quality of bypass surgery, and save more lives.

FIGURE ES-1:

TREND IN RISK-ADJUSTED MORTALITY (1994–99)



SOURCE: New Jersey Department of Health and Senior Services

SECTION 1.

Introduction

This is a report on the quality of care provided by hospitals and surgeons performing bypass surgery in New Jersey. It is the fourth in a series providing consumers with useful information on the quality of surgical care. The mortality or death rates of the bypass surgery patients measure the quality of surgical care provided by surgeons and hospitals. The rates are adjusted statistically by factors based on the health condition of patients before surgery.

This report provides hospitals and surgeons that perform coronary artery bypass graft (CABG) surgery (often called bypass surgery) with information to increase their understanding of the risk factors related to mortality for potential bypass surgery patients. Such information encourages them to examine their surgical procedures and make changes to improve the quality of bypass surgery in their facility, and save more lives.

Organization of this report

The report is divided into five main sections. After this Introduction, Section 2 provides background information on bypass surgery as a treatment for coronary artery disease. Section 3 describes the data collection process used to prepare this report and gives an account of the audits and checks for data accuracy. Section 4 presents the methods to identify significant before-surgery health factors and adjust the mortality estimates. Section 5 presents the results of our analysis in three parts:

(1) comparisons of risk-adjusted patient mortality for hospitals to the state average in 1999;

(2) comparisons of the statewide risk-adjusted patient mortality for each year in 1994–99 to the yearly average for the period; and

(3) comparisons of the risk-adjusted patient mortality for surgeons to the state average for 1998–99.

SECTION 2.

Background

Coronary Artery Disease and Bypass Surgery

According to the American Heart Association, someone in this country suffers a heart attack every 30 seconds, and every minute someone dies from a heart attack. Heart disease is the single largest killer of Americans. Its most common form is coronary artery disease.

Coronary artery disease is a chronic disease brought about when fat and cholesterol gradually deposit in the lining of blood vessels that supply the heart. The heart muscle works continuously and needs an adequate flow of blood to supply it with nutrients. Over time, fat deposits may harden and partially block blood vessels, causing a reduction in blood flow to the heart. This may lead to chest pains called angina, which are the warning signs for a heart attack (myocardial infarction). A heart attack occurs when the vessels carrying blood to the heart muscle are totally blocked.

The two most common surgical procedures for the treatment of coronary artery disease are CABG and percutaneous transluminal coronary angioplasty (PTCA). Despite recent significant increases in the number of PTCA operations performed, for many coronary artery disease patients, bypass surgery remains the treatment of choice. For many people, therefore, useful information on this surgical operation may be indispensable. This report attempts to provide the necessary data, information, and analysis.

In bypass surgery, the surgeon uses a healthy blood vessel from another part of the body to create an alternate path, or graft, for blood to flow to the heart, bypassing the blockage caused by the disease. That allows oxygen-rich blood to flow freely to nourish the heart muscle. Surgeons often create one, two, three, or sometimes more grafts for patients, depending on how many blood vessels (and their main branches) are blocked. Even though the operation is sometimes arduous for patients, it has been very successful in countering the effects of coronary artery disease.

Public Disclosure and Quality Improvement

In states that publicly disclose bypass surgery outcomes for hospitals and surgeons, significant reductions in bypass surgery mortality have been achieved. New York first published a bypass surgery report card in 1990, presenting 1989 data, and currently publishes a report card on angioplasty. Pennsylvania has published a cardiac report card starting with 1990 data. In New Jersey, we started reporting on patient mortality for bypass surgery hospitals and surgeons using 1994 and 1995 data. The experience from these states indicates that these disclosures have contributed to the initiation of many hospital quality improvement measures—and significant reductions in bypass surgery mortality. In New Jersey, mortality has declined substantially between 1994 and 1998. In this report we present the results from an analysis confirming that, despite a statistically insignificant upturn in 1999, a downward trend in mortality has continued into the sixth year.

SECTION 3.

The Bypass Surgery Data used for this report

For the analysis in this report, we used data on all adult patients in New Jersey who underwent bypass surgery with no other major surgery during the same admission. These are often called isolated bypass surgery patients. As in previous years, the data also include that from bypass surgery using the newer minimally invasive methods first performed in New Jersey in 1996.

The last report, "Cardiac Surgery in New Jersey, 1998," estimated risk-adjusted mortality for hospitals using 1998 data. That was the most current complete data set available for analysis at the time. This report presents risk-adjusted mortality for hospitals using 1999 data, the most recent complete data available for analysis. To produce statistically meaningful risk-adjusted patient mortality estimates for surgeons, at least two years of data are needed. To produce estimates for surgeons in this report, we therefore combined 1998 and 1999 data, the most recent complete two years available.

All licensed cardiac surgery centers in New Jersey submit, on a quarterly basis, data on adult bypass patients to the Department. The data include patient demographics, patient health history before bypass surgery, and whether the patient died in the hospital. The 1999 data include submissions from 14 licensed cardiac surgery centers. St. Barnabas Medical Center began cardiac surgery in 1999 as a satellite of the Newark Beth Israel Medical Center program. However, surgeons there did not begin performing open-heart operations until May 1999. Additionally, Englewood Hospital and Medical Center was licensed in July 2000 and Atlantic City Medical Center in August 2001. These newer cardiac surgery centers will be included in future reports when they have a full calendar year of data to report.

The Department sets the criteria for collecting data and checks the data using traditional quality checking procedures. Independent external teams of medical chart reviewers also audit and verify the accuracy of the data against the actual clinical records at each hospital. If discrepancies are found between the data submitted and the clinical records, hospitals must either provide corroborating documentation or revise their data. The Department also verifies the data submitted using other data sets, to confirm that all bypass surgery operations and all deaths from bypass surgery were reported.

Hospitals and Surgeons are not penalized for operating on high risk patients

This analysis takes into account the health status of patients to ensure that when surgeons operate on patients who are extremely ill, they will not be penalized. Hospitals may submit the clinical data on such patients for review and possible exclusion from the analysis. Members of the Department's clinical panel review the medical data on such patients (with all identifying information removed) and recommend which patients should be excluded from the report. Second, the analysis adjusts for the before-surgery health condition of patients. So hospitals and surgeons do not have a disincentive to treat patients who are extremely ill.

SECTION 4.

Identifying the factors affecting patients' risk of death

Observed patient mortality—the death rate—for the hospital or surgeon, is estimated as the number of patients who died in the hospital during or after surgery divided by the total number of patients who underwent the surgery.

In the past, this death rate has been used as an indicator of quality of care. However, it is not a complete measure of the quality of care provided by a hospital or a surgeon because it does not account for how sick the patients were before surgery. If one hospital had considerably sicker patients than another hospital, it would be expected that its mortality would be somewhat higher. So it would not be fair to evaluate surgeons and hospitals performing bypass surgery solely on the basis of the number of their patients that died.

Even though bypass surgery patients' risk of dying may depend on the surgical care they receive, it may also depend on their health condition before the bypass surgery. For instance, an 85-year-old

TABLE 1

RISK FACTORS IDENTIFIED FOR ISOLATED BYPASS SURGERY DEATHS (1999)

Patient Risk Factors Identified	Proportion of Patients (%)	Logistic Regression Results		
		Coefficient	P-Value	Odds Ratio
Demographic factors				
Age 70–74	18.7	0.4673	0.0121	1.596
Age 75–79	15.5	0.7543	<.0001	2.126
Age 80–84	7.0	0.9616	<.0001	2.616
Age 85 and Over	1.8	1.3511	<.0001	3.862
Female	28.7	0.3605	0.0119	1.434
Health factors				
Previous Heart Attack	46.2	0.2892	0.0454	1.335
Congestive Heart Failure in the 2 weeks before surgery	18.2	0.7334	<.0001	2.082
Kidney Failure with Dialysis	1.2	1.2648	0.0007	3.542
Kidney Failure without Dialysis	3.4	1.0123	<.0001	2.752
History of a Stroke	7.4	0.7368	<.0001	2.089
Lung Disease	13.0	0.6002	0.0002	1.822
Factors related to functioning of the heart				
Ejection Fraction less than 30%	9.0	0.4677	0.0114	1.596
Cardiogenic Shock present at the time of bypass surgery	1.7	0.6880	0.0366	1.990
Other factors				
Previous Open Heart Surgery	5.1	1.3405	<.0001	3.821
Intercept		–4.9189		
C-Statistic		0.781		

SOURCE: New Jersey Department of Health and Senior Services

man who has diabetes and previous heart surgery is at a higher risk of dying, when undergoing this surgery, than a 50-year-old man with no history of chronic disease or cardiac surgery.

To undertake an evenhanded analysis of the quality of surgical care provided by surgeons and hospitals performing bypass surgery, the Department uses a method that adjusts the observed patient death rates estimated for each surgeon and each hospital by risk factors based on each patient's before-surgery health condition. This method gives hospitals and surgeons who operate on less healthy patients "extra credit" so that they are not at a disadvantage when the outcome of the surgical care they provide is presented next to that by other hospitals and surgeons.

The method uses logistic regression techniques to assess the average risk of bypass surgery for all patients based on the important parts of the health history and experience of patients who have undergone bypass surgery in the same period. It takes into account both the outcome of bypass surgery, estimated by the number of patients who died, and a measure of how sick patients were before surgery.

Which risk factors were identified in this analysis as most important?

We tested a model including all the before-surgery factors in our data files to determine which health factors are important in determining whether a patient will die or not. The important risk factors identified from the method are presented in Table 1. The Table includes the list of risk factors; estimates of the coefficients for each significant risk factor, an indication of the level of statistical significance (p-values); and the odd ratios for each factor. It lists only the risk factors that were statistically significant in predicting mortality with p-values of 0.05 or smaller. The criteria used in collecting data on the patient risk factors identified by our model are presented in the Appendix.

The odd ratios are derived from the coefficients and are used to compare the relative importance of the risk factors in predicting mortality from bypass surgery.

For each of the age groups identified in Table 1, the odds ratio represents the number of times that a patient in that age group is likely to die in the hospital when compared to a patient who is under 70 years old. The under 70-year-old group is our reference group. For example, the Table shows that a patient between 80 and 84 years old has odds of dying in the hospital during or after bypass that are more than two and a half times (2.616) the odds of a patient who is less than 70 years old. This is based on the assumption that both patients have the same set of other risk factors presented in the Table. Similarly, the odds of a patient with an ejection fraction that is less than 30 percent dying in the hospital during or after bypass surgery are about one and a half times (1.596) the odds of a patient with an ejection fraction that is 30 percent or greater. The 30 percent or greater ejection fraction group is our reference group in this case. Also, the odds of a patient with renal failure with dialysis dying in the hospital are about three and a half times (3.542) the odds of a patient with no renal failure. Patients with no renal failure are our reference group in this case.

For each of the other risk factors presented in the Table, the odds ratio represents the odds of a patient with that risk factor dying in the hospital divided by the odds of a patient without the risk factor dying in the hospital. This is the number of times more likely that a patient with the risk factor may die in the hospital when compared to a patient without the risk factor, if the two patients are identical with respect to all the other risk factors presented in Table 1. For example, a patient who experienced congestive heart failure in the two weeks before bypass surgery has odds of dying in the hospital during or after surgery that are slightly more than twice (2.082) the odds of a patient who had no congestive heart failure.

How did we adjust mortality using the health history of patients?

The risk factors identified and presented in Table 1 were combined to predict the probability of death for each patient. An estimate of the average risk of patients dying for a particular hospital or a surgeon is obtained by summing the probabilities of dying for patients and dividing by the number of patients operated on in that hospital or by that surgeon. That estimate is the predicted or expected mortality for the hospital or surgeon.

To assess the quality of care provided by each hospital or surgeon, we compared what happened—the observed patient mortality—with what was expected or predicted to happen based on the risk factors for the hospital or surgeon's patients the expected patient mortality. First, the observed patient mortality is divided by the expected mortality. If the resulting ratio is greater than 1, the hospital or surgeon has a higher patient mortality than expected on the basis of their patient mix. If the ratio is smaller than one, the hospital or surgeon has a lower mortality than expected. The ratio is then multiplied by the statewide average patient mortality to produce the risk-adjusted patient mortality for the hospital or the surgeon.

The risk-adjusted mortality represents the best estimate, based on the associated statistical model of identified health risk factors, of what the hospital or surgeon's patient mortality would have been if they had a mix of patients identical to the statewide mix. Thus, the risk-adjusted patient mortality has, to the greatest extent possible, leveled the field among hospitals and among surgeons in the severity of illness of their patients.

The statistical methods are tested

The statistical methods used to predict mortality outlined above are tested to determine if they are sufficiently accurate in predicting death for all patients—for those who are severely ill prior to undergoing bypass surgery as well as those who are relatively healthy. In the analysis for this report, the tests confirmed that the model is reasonably accurate measure in predicting how patients of different risk levels will fare when undergoing bypass surgery.

SECTION 5.

The Risk-Adjusted Patient Mortality Estimates

This section presents the results of our analysis including:

(1) comparisons of risk-adjusted patient mortality for hospitals to the state average in 1999;

(2) comparisons of the risk-adjusted patient mortality for surgeons to the state average for 1998–99;

(3) comparisons of the statewide risk-adjusted patient mortality for each year in 1994–99 to the yearly average for the period. The risk-adjusted mortality estimates are presented in percentage points. The results also include expected ranges representing the lowest and the highest mortality one would expect within 95 percent confidence intervals.

Comparing Risk-Adjusted Patient Mortality for each hospital to the state average in 1999

The risk-adjusted patient mortality estimates from bypass surgery for each hospital in 1999 are presented in Table 2. The results compare each hospital's risk-adjusted patient mortality, expressed in percentage points, with the statewide mortality. The observed mortality statewide in 1999 for bypass patients was 2.89 percent, based on 234 deaths out of 8,108 bypass operations performed.

As in previous reports, there was substantial variation in the observed patient mortality from bypass surgery across hospitals in 1999. It ranged from 1.24 percent in Jersey Shore Medical Center to 5.13 percent in Newark Beth Israel Medical Center. Two hospitals had patient mortality estimates above 4 percent. However, 9 of the 14 hospitals that do bypass surgery had estimates between 2 and 4 percent.

After adjusting for how sick the patients were before surgery at each hospital, we present the estimates of risk-adjusted patient mortality for each

TABLE 2

COMPARING PATIENT MORTALITY FROM BYPASS SURGERY IN HOSPITALS TO STATE AVERAGE (1999)

Hospital	Number of Bypass Operations	Patient Deaths	Observed Patient Mortality (%)	Expected Patient Mortality (%)	Risk-Adjusted Patient Mortality (%)	95% Confidence Interval
Cooper Hospital/University Medical Center	274	7	2.55	3.22	2.29	(0.92 , 4.71)
Deborah Heart and Lung Center	764	20	2.62	2.63	2.87	(1.75 , 4.43)
General Hospital Center at Passaic	375	7	1.87	2.28	2.36	(0.95 , 4.87)
Hackensack University Medical Center	794	24	3.02	3.14	2.78	(1.78 , 4.14)
Jersey Shore Medical Center	485	6	1.24	2.74	1.31 **LO**	(0.48 , 2.84)
Morristown Memorial Hospital	1,136	24	2.11	2.29	2.66	(1.71 , 3.96)
Newark Beth Israel Medical Center	448	23	5.13	4.35	3.41	(2.16 , 5.11)
Our Lady of Lourdes Medical Center	834	29	3.48	2.73	3.68	(2.47 , 5.29)
Robert Wood Johnson University Hospital	1,043	40	3.84	3.20	3.46	(2.47 , 4.71)
St Francis Medical Center	213	5	2.35	3.16	2.14	(0.69 , 5.00)
St Joseph's Hospital and Medical Center	462	15	3.25	3.02	3.10	(1.73 , 5.11)
St Michael's Medical Center	508	9	1.77	2.92	1.75	(0.80 , 3.32)
UMDNJ University Hospital	165	7	4.24	3.36	3.64	(1.46 , 7.51)
Valley Hospital	607	18	2.97	2.58	3.32	(1.97 , 5.25)
State Total (1999)	8,108	234	2.89	2.89	2.89	

SOURCE: New Jersey Department of Health and Senior Services.

NOTES: **LO**—The risk-adjusted patient mortality is significantly lower than the state average mortality when evaluated with a 95 percent confidence interval.

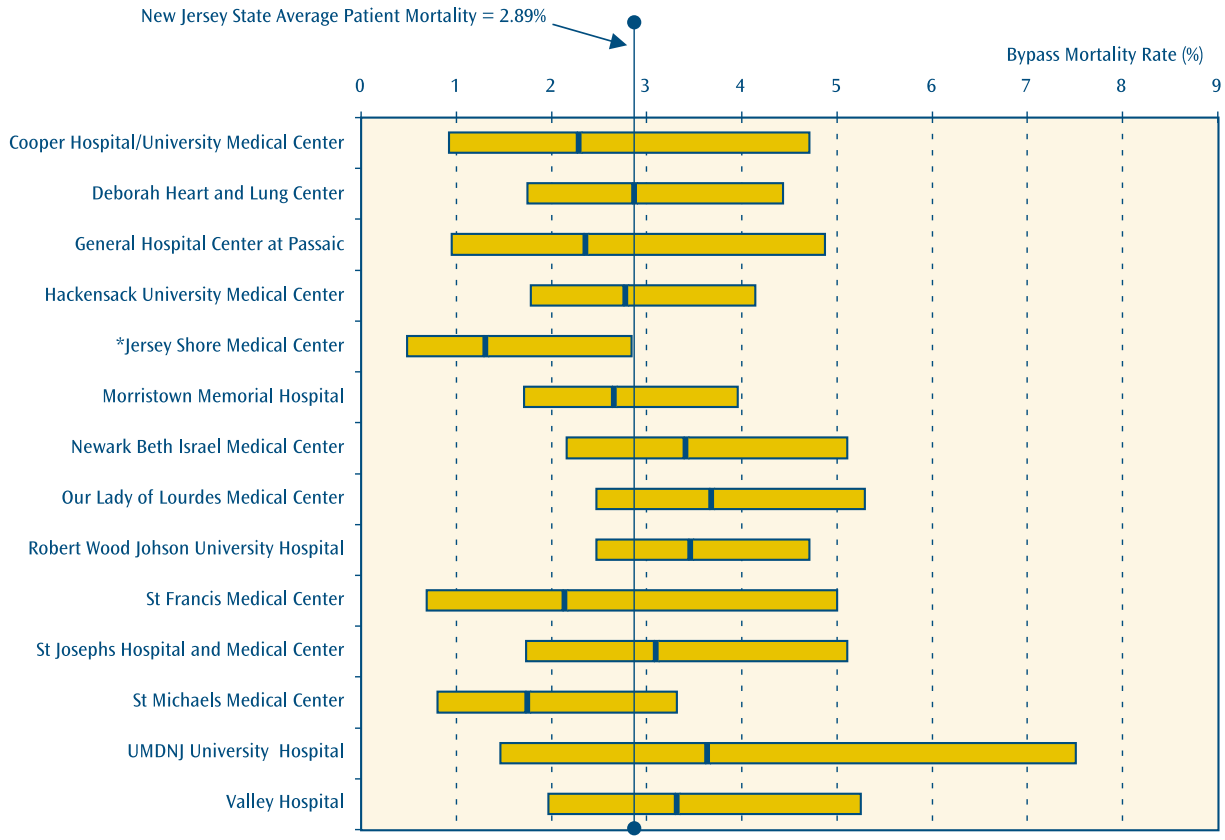
hospital in the sixth column of Table 2, and graphically in Figure 1. In the graph, the risk-adjusted mortality estimate is presented as a dark narrow bar in the middle of a broader shaded bar that represents the confidence interval around the estimate. The graph also presents a vertical line drawn to represent the state average patient mortality at 2.89 percent. This line is important because all risk-adjusted patient mortality estimates are meaningful only when compared to the statewide average mortality.

If a hospital's shaded bar crosses the state average vertical line, it means that the difference between the hospital's risk adjusted mortality and the state average was not statistically significant. If the whole of a hospital's shaded bar clearly falls to the left of the state average vertical line it means that the hospital's risk adjusted patient mortality was statistically lower than the state average. If the whole bar falls to the right of the state average vertical line it means that the hospital's risk adjusted mortality was statistically higher than the state average.

The results in Figure 1 show that none of the hospitals had their shaded bar fall to the right of the state average vertical line in 1999. This means that no hospital had risk-adjusted patient mortality statistically higher than the state average. One hospital (Jersey Shore Medical Center) had its shaded bar fall clearly to the left of the state average vertical line. This means that Jersey Shore Medical Center's patient mortality from bypass surgery was statistically lower than the state average.

FIGURE 1

COMPARING RISK-ADJUSTED PATIENT MORTALITY FOR BYPASS SURGERY IN HOSPITALS TO STATE AVERAGE (1999)



SOURCE: New Jersey Department of Health and Senior Services

* Risk-adjusted mortality significantly lower than the New Jersey rate when evaluated with a 95 percent confidence interval.

For all other hospitals, the shaded bar crosses the state average vertical line. This means that the risk-adjusted mortality estimates for each of these hospitals were not statistically different from the state average.

Comparing the Statewide Risk-adjusted Patient Mortality for each year in 1994–99 to the yearly average for the period

Table 3 presents the results of an analysis to identify any trend in the statewide mortality of patients who underwent bypass surgery using a statistical model based on data collected over the six-year period (1994–99). The Table presents the observed patient mortality, expected mortality, and the risk-adjusted patient mortality statewide for each of the six years. It also presents the 95 percent confidence intervals, and an indication as to whether the risk-adjusted mortality for the year is statistically different from the average mortality over the six-year period.

It shows that from 1998 to 1999, the number of bypass operations performed in New Jersey decreased from 8,377 to 8,108. Over the same period, the number of deaths increased slightly from 218 to 234. This resulted in a slight increase in the observed patient mortality from 2.6 percent in 1998 to 2.89 percent in 1999. Despite this increase (0.29 percentage points), the long-term trend in statewide patient mortality is still downward: the 1999 statewide rate of 2.89 percent is still lower than the rates prior to 1998.

The Table also shows that, when adjusted for how sick the patients were before surgery, the increase in risk-adjusted patient mortality between 1998 and 1999 is even smaller (0.08 percentage points). For most of the period, risk-adjusted mortality has dropped by more than 0.50 percentage points every year. The exceptions are from 1994 to 1995 when mortality increased slightly by 0.25 percentage points and 1998 to 1999, when it increased by 0.08 percentage points. When compared to 1994, patient mortality in 1999 has dropped by more than 36 percent.

When subjected to statistical tests, the 1999 risk-adjusted patient mortality is not significantly different from the 1998 estimate. Both the 1998 and 1999 mortality estimates were significantly lower than the average mortality for the 1994–99 period, while the 1994, 1995, and 1996 risk-adjusted patient mortality estimates were significantly higher than the average patient mortality for the period, indicating a trend towards lower mortality. This long- term trend continues despite the small increase in 1999.

TABLE 3
COMPARING RISK-ADJUSTED PATIENT MORTALITY FOR EACH YEAR TO THE YEARLY AVERAGE FOR THE PERIOD (1994–99)

Calendar Year	Number of Bypass Operations	Patient Deaths	Observed Patient Mortality (%)	Risk-Adjusted Patient Mortality (%)	Yearly Change in Risk-Adjusted Mortality (%)	Change from 1994 Risk-Adjusted Mortality (%)
1994	6,957	248	3.56	4.02 **HI**	—	—
1995	7,553	296	3.92	4.27 **HI**	0.25	6.2
1996	8,262	302	3.66	3.72 **HI**	–0.55	–7.5
1997	8,286	255	3.08	3.03 **SA**	–0.69	–24.6
1998	8,377	218	2.60	2.48 **LO**	–0.55	–38.3
1999	8,108	234	2.89	2.56 **LO**	0.08	–36.3
1994–1999	47,543	1,553	3.27	3.27		

SOURCE: New Jersey Department of Health and Senior Services

NOTES: **LO**—The risk-adjusted patient mortality is significantly lower than the state average mortality for the 1994–99 period when evaluated with a 95 percent confidence interval
SA—The risk-adjusted patient mortality is same as the state average mortality for the 1994–99 period when evaluated with a 95 percent confidence interval
HI—The risk-adjusted patient mortality is significantly higher than the state average mortality for the 1994–99 period when evaluated with a 95 percent confidence interval

Comparing Risk Adjusted Patient Mortality for Surgeons to the state average for 1998–1999

This report presents risk-adjusted patient mortality for surgeons, using two years of data (1998 and 1999), because this is adequate to produce statistically meaningful results with the methods used in this analysis. One year of data for surgeons is not adequate.

Even with data from two years of operations, some bypass surgeons performed less than 100 isolated bypass operations in New Jersey. Surgeons in each hospital who performed fewer than 100 operations in the two years were placed in one group and risk-adjusted patient mortality was estimated for the group instead of for the surgeons individually.

In this section and in Table 4, we present the results on patient mortality for surgeons for 1998–99. The results present mortality in percentage points and compare each surgeon's risk-adjusted patient mortality from bypass surgery with the state average mortality estimate.

The state average mortality for bypass surgery patients in the two years (1998–99) was 2.74 percent, based on 452 deaths out of 16,485 bypass operations performed. The table shows three surgeons who performed at least 100 bypass operations with risk-adjusted patient mortality estimates significantly higher than the average state patient mortality. It also shows three other surgeons whose patient mortality rates were significantly lower than the 1998–99 state average. As indicated in the previous reports, the patient mortality estimates of the majority of surgeons were not statistically different from the state average.

TABLE 4

PATIENT MORTALITY FOR SURGEONS PERFORMING BYPASS OPERATIONS (1998–99)

Hospital and Surgeon	Number of Bypass Operations	Patient Deaths	Observed Patient Mortality (%)	Expected Patient Mortality (%)	Risk-Adjusted Patient Mortality (%)	95% Confidence Interval
Cooper Hospital/University Medical Center						
Cilley, Jonathan	142	4	2.82	2.87	2.69	(0.72 , 6.88)
Mara, Steven	119	4	3.36	2.57	3.59	(0.97 , 9.19)
Seven Other Surgeons	286	11	3.85	2.57	4.11	(2.05 , 7.35)
Deborah Heart and Lung Center						
Anderson, William	310	8	2.58	3.17	2.24	(0.96 , 4.40)
Grosso, Michael	282	6	2.13	3.01	1.94	(0.71 , 4.21)
McGrath, Lynn	649	11	1.69	2.07	2.25	(1.12 , 4.02)
Ng, Arthur	290	12	4.14	3.09	3.67	(1.90 , 6.42)
One Other Surgeon	15	1	6.67	2.20	8.31	(0.11 , 46.2)
General Hospital Center at Passaic						
Goldenberg, Bruce	169	4	2.37	2.32	2.80	(0.75 , 7.16)
Kaushik, Raj	258	4	1.55	2.42	1.76	(0.47 , 4.50)
Saxena, Amarkanth	254	5	1.97	2.06	2.62	(0.84 , 6.10)
Four Other Surgeons	151	3	1.99	1.89	2.89	(0.58 , 8.44)
Hackensack University Medical Center						
Alexander, John	120	5	4.17	4.21	2.71	(0.87 , 6.33)
Brenner, William	152	7	4.61	2.37	5.32	(2.13 , 11.0)
Elmann, Elie	277	7	2.53	4.91	1.41	(0.56 , 2.91)
Hutchinson III, John	240	14	5.83	2.77	5.77	(3.15 , 9.68)
Praeger, Peter	376	6	1.60	2.62	1.67	(0.61 , 3.63)
Somberg, Eric	417	6	1.44	2.52	1.57	(0.57 , 3.41)
Jersey Shore Medical Center						
Dejene, Brook	106	5	4.72	2.92	4.43	(1.43 , 10.3)
Neibart, Richard	215	4	1.86	2.33	2.19	(0.59 , 5.61)
Oselava, Mark	213	1	0.47	2.23	0.58	(0.01 , 3.21)
Rajaii-Khorasani, Ahmad	232	3	1.29	3.73	0.95	(0.19 , 2.78)
Five Other Surgeons	234	2	0.85	2.28	1.03	(0.12 , 3.70)
Morristown Memorial Hospital						
Brown III, John	489	5	1.02	2.16	1.30	(0.42 , 3.03)
Casale, Alfred	427	12	2.81	2.33	3.31	(1.71 , 5.78)
Johnson, David	307	1	0.33	2.44	0.37	(0.00 , 2.03)
Magovern, Christopher	308	3	0.97	2.00	1.34	(0.27 , 3.91)
Parr, Grant	286	7	2.45	2.35	2.86	(1.15 , 5.89)
Rodriguez, Alejandro	363	8	2.20	2.01	3.01	(1.29 , 5.93)
Two Other Surgeons	133	3	2.26	2.15	2.88	(0.58 , 8.40)
Newark Beth Israel Medical Center						
Gielchinsky, Isaac	122	9	7.38	3.91	5.17	(2.36 , 9.82)
Karanam, Ravindra	269	9	3.35	2.87	3.19	(1.46 , 6.06)
Saunders, Craig	194	10	5.15	3.97	3.56	(1.70 , 6.54)
Eight Other Surgeons	277	23	8.30	3.69	6.18	(3.91 , 9.27)

CONTINUED ON PAGE 18

TABLE 4 (continued)

Hospital and Surgeon	Number of Bypass Operations	Patient Deaths	Observed Patient Mortality (%)	Expected Patient Mortality (%)	Risk-Adjusted Patient Mortality (%)		95% Confidence Interval
Our Lady of Lourdes Medical Center							
Di Paola, Douglas	233	8	3.43	2.86	3.30		(1.42 , 6.50)
Eisen, Morris	161	7	4.35	2.20	5.41		(2.17 , 11.1)
Heim, John	159	11	6.92	2.81	6.76	○	(3.37 , 12.1)
Kuchler, Joseph	258	6	2.33	2.38	2.68		(0.98 , 5.83)
Luciano, Pasquale	244	7	2.87	2.56	3.07		(1.23 , 6.32)
Nayar, Amrit	187	8	4.28	2.83	4.15		(1.79 , 8.17)
Ray, Subhash	105	5	4.76	2.89	4.52		(1.46 , 10.6)
Santaspirt, John	213	4	1.88	2.49	2.07		(0.56 , 5.30)
Eight Other Surgeons	216	4	1.85	2.00	2.54		(0.68 , 6.49)
Robert Wood Johnson University Hospital							
Krause, Tyrone	987	31	3.14	3.42	2.52		(1.71 , 3.58)
Scholz, Peter	232	7	3.02	2.73	3.03		(1.21 , 6.24)
Scott, Gregory	469	16	3.41	3.02	3.09		(1.77 , 5.02)
Spotnitz, Alan	204	6	2.94	2.32	3.47		(1.27 , 7.56)
Vasseur, Bernard	165	3	1.82	3.19	1.56		(0.31 , 4.56)
One Other Surgeon	40	2	5.00	4.22	3.25		(0.36 , 11.7)
St Francis Medical Center							
Laub, Glenn	421	5	1.19	3.46	0.94	●	(0.30 , 2.20)
One Other Surgeon	30	0	0.00	2.96	0.00		(0.00 , 11.3)
St Joseph's Hospital and Medical Center							
Defilippi, Vincent	300	7	2.33	3.22	1.99		(0.80 , 4.10)
Levy, Dale	120	10	8.33	4.54	5.03		(2.41 , 9.26)
Mekhjian, Haroutune	460	15	3.26	2.46	3.63		(2.03 , 5.98)
Two Other Surgeons	42	1	2.38	2.39	2.73		(0.04 , 15.2)
St Michaels Medical Center							
Asher, Alain	339	5	1.47	2.64	1.53		(0.49 , 3.58)
Codoyannis, Aristides	282	6	2.13	2.49	2.34		(0.85 , 5.09)
Esrig, Barry	168	0	0.00	2.72	0.00	●	(0.00 , 2.20)
Eleven Other Surgeons	200	9	4.50	2.41	5.12		(2.33 , 9.71)
UMDNJ University Hospital							
McCormick, J.	108	8	7.41	3.08	6.58	○	(2.83 , 13.0)
Four Other Surgeons	166	4	2.41	3.26	2.02		(0.54 , 5.18)
Valley Hospital							
Bronstein, E.	480	9	1.88	2.31	2.22		(1.01 , 4.22)
Mindich, Bruce	434	14	3.23	2.79	3.17		(1.73 , 5.32)
Rubinstein, M.	245	7	2.86	2.33	3.37		(1.35 , 6.94)
Two Other Surgeons	135	4	2.96	2.81	2.89		(0.78 , 7.39)
State Total (1998–99)	16,485	452	2.74	2.74	2.74		

● Risk-adjusted patient mortality is significantly lower than state average within a 95 percent confidence interval

◒ Risk-adjusted patient mortality is same as state average within a 95 percent confidence interval

○ Risk-adjusted patient mortality is significantly higher than state average within a 95 percent confidence interval

SOURCE: New Jersey Department of Health and Senior Services

SECTION 6.

Conclusions

In this report we presented the results of analysis using data from 1998 and 1999 on patient mortality for surgeons and data from 1999 on patient mortality for hospitals. The data show the following:

- In 1999, the risk-adjusted patient mortality estimates for most hospitals were not different from the state average. However one hospital (Jersey Shore Medical Center) had an estimate significantly lower than the state average.
- In 1998 and 1999, risk-adjusted patient mortality estimates for most surgeons performing bypass operations were no different than the state average. Three surgeons had estimates significantly higher than the state average; three surgeons had estimates significantly lower than the state average.
- Over most of the six years (1994–99) risk-adjusted patient mortality has dropped substantially. Even though there was a slight increase in risk-adjusted mortality in 1999 over 1998, this mortality estimate is not statistically significant. When compared to 1994, patient mortality in 1999 has dropped by more than 36 percent.

The information presented in this report should encourage hospitals and surgeons to examine their surgical procedures and make changes to improve the quality of bypass surgery in their hospitals, and save more lives.

APPENDIX.

Data collection definitions for identified risk factors (1998–99)

PATIENT RISK FACTORS	DEFINITIONS
DEMOGRAPHIC FACTORS	
1. Age	Age is calculated from the patient's date of birth up to the date of bypass surgery procedure
2. Female	
HEALTH FACTORS	
3. Previous Heart Attack (Myocardial Infarction)	Documented evidence that the patient has been hospitalized for a heart attack with at least two of the following four criteria: 1) prolonged "typical" chest pains (>20 minutes) not relieved by rest and/or medication. 2) enzyme level elevations indicating damaged heart muscles, either • CK-MB greater than 5 percent of total CPK, • CK greater than two times normal, • LDH subtype 1 greater than LDH subtype 2, or • Troponin greater than 0.3 micrograms/ml; 3) new heart wall motion abnormalities that indicate that the heart is not functioning normally; 4) at least two consecutive measurements of heart function test (serial ECG tracings) showing changes from baseline or serially in ST-T and/or Q-waves that are .03 seconds in width, and/or greater than or equal to one-third of the total QRS complex in two or more contiguous leads.
4. Congestive Heart Failure (CHF) in prior 2 weeks	Congestive heart failure (CHF) occurring in the two weeks before the current bypass surgery. One or more of the following must be present in the two weeks before the surgery for CHF to have been diagnosed: • severe nighttime trouble breathing (paroxysmal nocturnal dyspnea); • trouble breathing (dyspnea) on exertion due to heart failure; • lung congestion (pulmonary) by chest x-ray.
5. Renal Failure	Documented history of kidney failure or blood serum creatinine level greater than 2.0 mg/dl.
6. Dialysis	Patient was on support to clean blood using either hemodialysis or peritoneal dialysis.
7. History of a stroke	A stroke documented by any of the following: • Unresponsive Coma of more than 24 hours—Patient experienced complete mental unresponsiveness and no evidence of psychological or physiologically appropriate response to stimulation. • Cerebrovascular Accident—Patient has history of stroke, i.e., loss of neurological function due to loss of blood circulation in an area of the brain with residual symptoms lasting 72 hours or more after onset.

PATIENT RISK FACTORS	DEFINITIONS
	• Reversible Ischemic Neurologic Deficit—Patient has a history of loss of neurological function due to loss of blood circulation in an area of the brain with symptoms lasting longer than 24 hours after onset but with complete return of function within 72 hours. • Transient Ischemic Attack-Patient has a history of loss of neurological function due to loss of blood circulation in an area of the brain that was abrupt in onset but patient had complete return of function within 24 hours. • Non-invasive carotid artery test with blockage of more than 75%.
8. Lung Disease	Patient has trouble breathing, with clinical documentation of prescription for inhalers or theophylline/aminophylline or steroids; or other indications of reduced lung function such as: • forced Expiratory Volume 1 (FEV1) of less than 75%; • reduced blood oxygen levels without supplemental oxygen support. (Room air pO_2 less than 60); or • increased carbon dioxide blood levels (Room air pCO_2 more than 50).
FACTORS RELATED TO FUNCTIONING OF THE HEART	
9. Ejection Fraction	The percentage of blood emptied from the chamber of the heart at the end of a beat (ranges between 5% and 95%). Measurement is done closest to current surgery.
10. Cardiogenic Shock at time of procedure	At the time of surgery, patient has extremely low blood pressure (hypofusion) according to any of the following criteria: • systolic pressure 80 mm mercury and central filling pressure greater than 20 mm mercury Hg; • cardiac index less than 1.8 liter/minute m2; • intravenous medication (inotropes) and/or an Intra-Aortic Balloon Pump (IABP) necessary to maintain Systolic blood pressure greater than 80 and/or Cardiac Index greater than 1.8.
OTHER FACTORS	
11. Previous Open Heart Surgery	Patient has undergone a previous open heart surgery. May include procedure during current hospital admission.

New Jersey Department of Health and Senior Services
Health Care Systems Analysis
Research and Development
PO Box 360
Trenton NJ 08625-0360